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Radical Operation for Cancer of the Pyloric End of the Stomach

REVIEW OF 266 PARTIAL GASTRECTOMIES

ROYAL COLLEGE OF SURGEONS OF ENGLAND
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The operation of partial gastrectomy and pylorectomy has been performed in St. Mary's Hospital, Rochester, Minn., 266 times (C. H. and W. J. Mayo, April 21, 1897 to Jan. 27, 1910) with thirty-four deaths, an average mortality of 12.4 per cent. During the year 1909 there were forty-six operations with four deaths, an average mortality of 8.6 per cent. Forty-two of the 266 operations were performed for benign tumors, or ulcers, or the diagnosis was not microscopically established; they have, therefore been excluded from the statistics.

TABLE 1.—OPERATIONS FOR CARCINOMA INVOLVING THE PYLORIC END OF THE STOMACH

Total number	224
Males	163
Females	61
Age of oldest	81
Age of youngest	30
Average age	53

PATIENTS OPERATED ON OVER FIVE YEARS AGO

Total number	50
Present condition known	39
Alive and well (one 8 years 2½ months; one 8 years; *one 7 years, 2 months; one 6 years; one 6 years, 11 months; one 5 years, 3½ months; one 5 years	8

* Has since died of recurrence.

PATIENTS OPERATED ON OVER FOUR YEARS AGO

Total number	85
Present condition known	64
Alive and well	13

PATIENTS OPERATED ON OVER THREE YEARS AGO

Total number	117
Present condition known	88
Alive and well	18

PATIENTS OPERATED ON LESS THAN THREE YEARS AGO

Total number	107

Cases in the last group (operations less than three years ago) are too recent to be of any statistical value as to the question of cure.

Partial gastrectomy for the cure of malignant disease of the stomach has never been favorably accepted, and, considering that this organ is more frequently the seat of cancer than any other in the human body, the percentage of operations has been exceedingly small. The reluctance of practitioners to advise and of surgeons to practice partial gastrectomy is based on several considerations: First, in the greater number of cases the disease cannot be diagnosticated in time to affect a radical cure. Second the operation itself has an immediate mortality which is high in proportion to the ultimate prospect of cure. I do not believe this pessimism to be justified by the facts.

It is my intention, not to go into the details of the diagnosis of gastric cancer, but to call attention to two important indications for operation, which, if observed early, will be the means of securing a number of patients in time to benefit them. 1. Food remnants found repeatedly in the stomach after twelve hours, when taken in connection with the clinical history, should indicate a surgical consultation and, in the large majority of cases, this special investigation will lead to an exploratory operation. 2. The finding of a movable tumor in the pyloric end of the stomach has a surgical significance which cannot be overestimated. It is a great mistake to suppose that the presence of a movable tumor, palpable through the abdominal wall, is indicative of a hopeless condition. While it is true that ulcer and its results often give rise to gastric retention and occasionally to tumor, other things being equal, surgical relief is quite necessary in these cases.

Without in any way minimizing the value of laboratory examinations of the stomach contents etc., I am more and more convinced that gastric cancer itself does not give rise to diagnostic symptoms during the curable stage. In the later stages the clinical picture and laboratory findings are characteristic; by this time, unfortunately, the prognosis is equally as plain as the diagnosis, but, if the diseease is situated in the pyloric end of the stomach, it early introduces mechanical conditions which furnish the most valuable information..

Heretofore we have asked for a diagnosis in carcinoma of the stomach and have shifted the burden of responsibility to the internist. In the future let us ask, rather, for surgical consultation in all cases showing evidences of mechanical obstruction or tumor.

So much can be said concerning the doubtful group of cancers from which we obtain our cases in which cure is possible; but what shall be said as to the desirability of operation in advanced cases? Partial gastrectomy offers a number of months of apparent cure, even when it is impossible to remove all of the involved lymphatics, and with a mortality but slightly above that of gastrojejunostomy which, at best, gives only a few months of more or less uncomfortable existence.

Mikulicz has called special attention to the marked palliation which is produced by removal of the sloughing mass, as contrasted with methods which look only to overcoming the obstruction.

In a high percentage of cases, cancer of the stomach is, at the first examination, plainly inoperable, and without exploration, other cases are doubtful.

Palmer studied the histories of 335 patients suffering from cancer of the digestive tract, who presented themselves at our clinic between Jan. 1, 1908 and Sept. 1, 1909, and found the following definite signs of metastasis: (1) implantation carcinoma of the sigmoid, "the rectal shelf of Blumer"; (2) supraclavicular metastasis; (3) carcinomatous involvement of the umbilicus (buttonlike umbilicus); (4) free fluid in the peritoneum. These various conditions, by reason of the metastasis alone, eliminated about 12 per cent. of the total number as hopeless at the time of the primary examination.

TABLE 2.—CASES OF CANCER OF THE STOMACH EXAMINED IN THE CLINIC BETWEEN JAN. 1, 1908, AND SEPT. 1, 1909

Total number	335
Hopeless and not admitted to the hospital	146
Resections	78
Gastrojejunostomies	39
Excision malignant ulcer	2
Exploration inoperable disease	70
	335

TECHNIC OF OPERATION

As regards the technic of pylorectomy and partial gastrectomy, I have little to present that is new. An effort should always be made to remove the lymphatic area whether it is diseased or not. The general rule holds good, in the earlier stages at least, that the glandular involvement follows the regular lymphatic routes to the four primary groups of lymphatic glands into which the pyloric end of the stomach drains. We have observed, both in cancer and in ulcer, that when there was glandular involvement of only moderate degree, the evident adenopathy was usually confined to the glandular groups which accompany the four arteries, the superior pyloric, the gastric, the gastroduodenal and gastroepiploic. The lymphatics in this region eventually drain into the celiac and pre-aortic glands but by routes that are far from regular. Wilson and MacCarty, in a study of the lymphatics in a large number of cases in which we had made partial gastrectomy, have found a curious tendency of the disease to pass by certain glands, and have demonstrated that carcinomatous emboli in the early stages do not necessarily involve glands one after another, but may primarily pass into glands at a considerable distance.

Explorations and palliative gastrectomies have given me opportunities to note the glandular involvement in the late stages of the disease. In such cases, due either to unsuspected primary lymphatic connections or obstruction to the regular lymphatic channels causing extension along bypaths, I have seen involvement of the glands in the transverse mesocolon, the glands about the common duct, those along the upper border of the pancreas, and in other situations. It is evident, therefore, that removal of the lymphatic area in gastric cancer is not a simple proposition and it indicates only too clearly that to secure the best results, the disease must be removed before the lymphatics are infected.

Prophylaxis of gastric cancer can be aided by the excision of calloused ulcers of the stomach. In the 266 cases in which we have performed resection, Wilson and MacCarty examined histologically 218, and were able to show that 71 per cent. of the cancers had their origin in chronic gastric ulcer.

We have seen primary cancer of the duodenum in but five cases, and in only one of these did it appear that the cancer might have its origin in previous ulcer of the duodenum. This justifies the belief that gastrojejunostomy is the operation of choice for duodenal ulcer. In two instances, however, we found a gastric cancer which apparently had its origin on the gastris side of a duodenal ulcer which involved the pylorus. For gastric ulcer, the removal of the ulcer itself would seem to be the only safe procedure. We have practiced this for several years wherever it seemed possible and in a number of instances have unexpectedly found cancer on ulcer in the early stage.

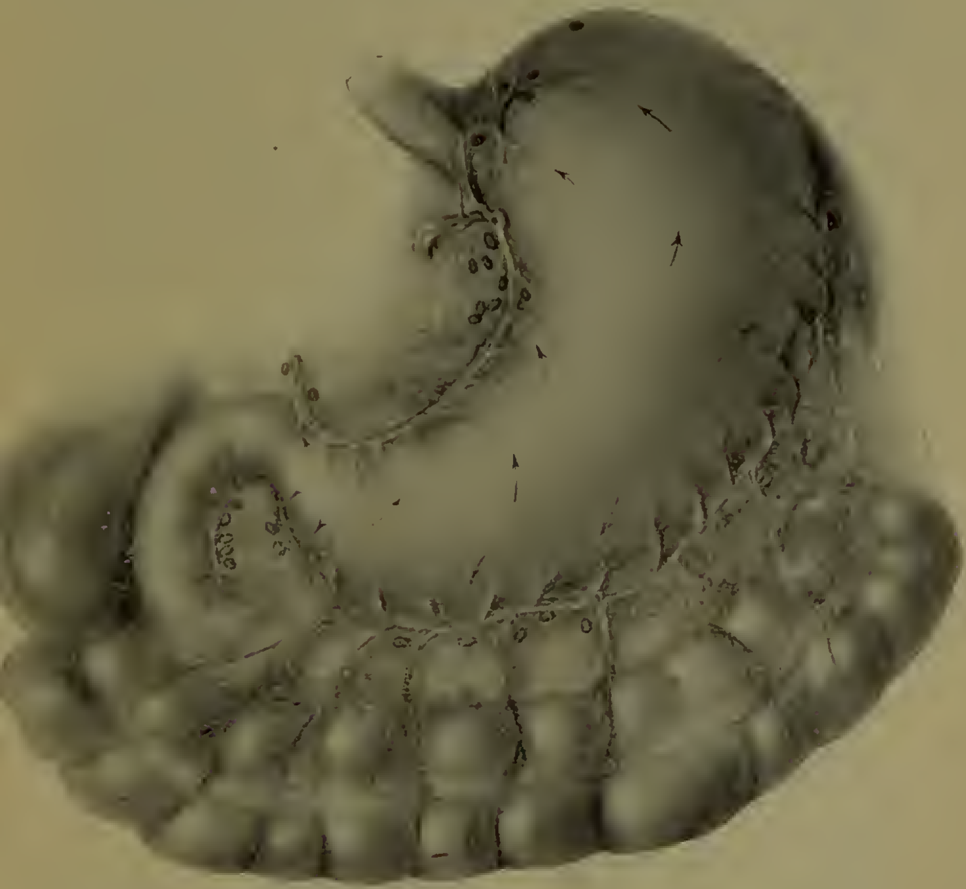

Fig. 1.—Anatomy of the stomach with especial reference to the blood-vessels and lymphatics. The arrows indicate the direction of the lymphatic flow.
The drawings are by Dorothy Peters.

The fundus of the stomach, like the fundus of other organs as contrasted with the neck, is not largely supplied with lymphatics, and those present lie, to a large extent, in the vicinity of the cardiac orifice. The fundus, from a line about opposite the cardia, passes its lymph-streams upward into the lymphatic glands about the cardia and to the left to the glands lying in the vicinity of the spleen, making a rather sharp lymphatic demarcation between the fundus and the pyloric end of the stomach. This indicates the amount of stomach necessary to be removed in pyloric cancer and makes pylorectomy and partial gastrectomy a fairly definite procedure. (Fig. 1).

A typical resection necessitates the removal of all of that part of the stomach lying to the right of a line dropped vertically from the cardiac orifice, although in some cases more of the fundus must be removed on account of direct extension of the disease. It sometimes happens that either the anterior or the posterior wall is more extensively diseased than the other. In this event we have not found it difficult to remove more of the diseased wall of one than the other, and to throw the suture line anterior or posterior as the necessity may indicate.

Billroth, to whose far-sighted pioneer work in gastric surgery we owe so much, had to contend with shock from loss of blood, which is now obviated by primary ligation of the blood-vessels. From a technical standpoint, the glands and gland-bearing fascia can best be removed at the time the blood-vessels are ligated, and the early ligation of these vessels not only makes the part of the stomach to be removed avascular, but also separates it from its connections so that the succeeding steps in the operation are greatly facilitated.

The blood-vessels are four in number, each accompanied by definite lymphatic channels and glands. These blood-vessels have their origin from the celiac axis, the gastric artery directly from the celiac axis, the superior pyloric and gastroduodenal by way of the hepatic artery, and the left gastro-epiploic from the splenic artery. As a general rule it will be most convenient to make the separation of the superior border of the stomach first, beginning the operation by (a) ligation of the superior pyloric vessel, (b) the gastric, (c) the left gastro-epiploic, (d) the gastro-duodenal vessels. As each vessel is secured, the glandular separation is effected. The procedure is as follows: (Fig. 2).

Step 1.—An opening is made through the gastrohepatic omentum into the lesser cavity of the peritoneum. The superior pyloric artery is isolated at as great a distance as possible from the duodenum and is double-tied and divided between.

The terminal branches are dissected upward from the duodenum so that they hang with the glands and fat attached about the pyloric ring. This frees the superior border of the duodenum for an inch and a half or two inches. The glands accompanying the superior pyloric artery are very often involved, and it should be remembered in separating them that the common duct lies in close proximity and may be exposed to injury. In one case I accidentally cut the common duct through three-fourths of its circumference transversely. It was sutured with catgut and a separate drain through a stab wound employed through which there was a biliary discharge for nearly three weeks. On two occasions I found the gallbladder attached by the fundus to a pyloric growth and it was removed without difficulty as it lay attached. Adhesions to the liver, if present, are separated at this stage of the operation.

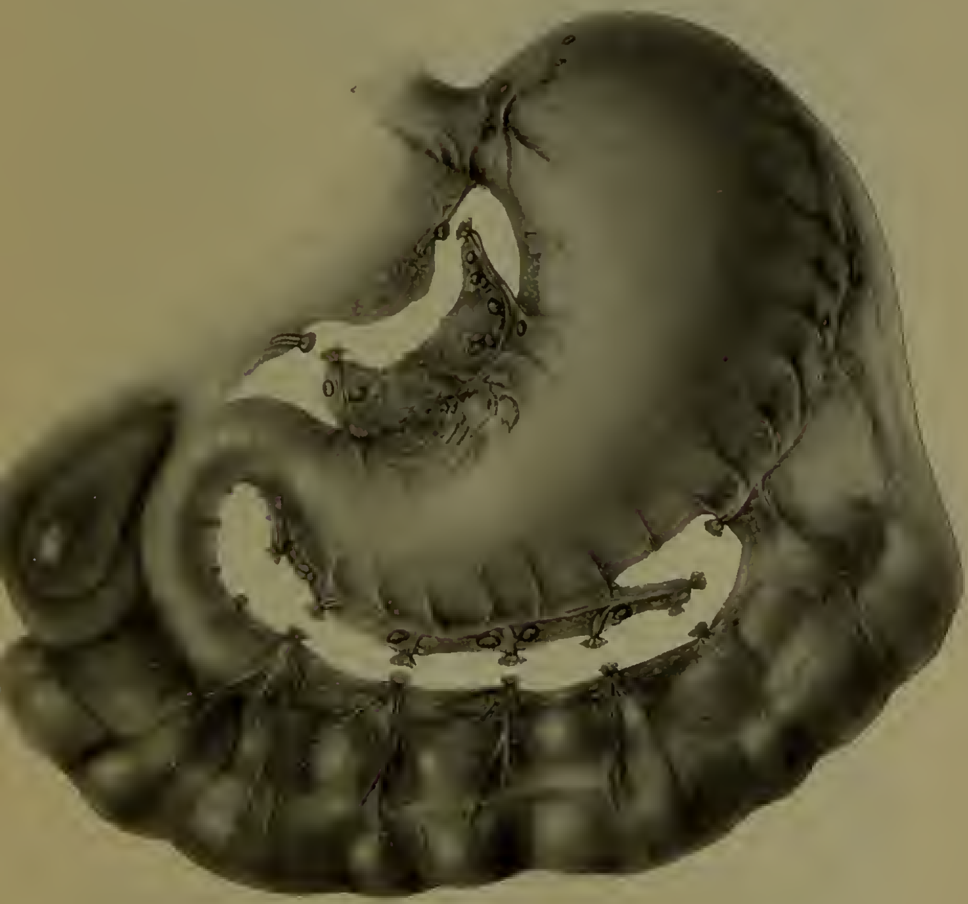

Fig. 2.—Vessels ligated and lymphatic dissection completed.

Step 2.—The stomach is drawn downward and to the right and the gastric artery is caught at the highest possible point. In thin subjects it may be ligated close to the celiac axis, but in the average case it will be most easily isolated just distal to the large branch which leads up to the esophagus and cardia.

This ligation is usually made from a needle with two independent ties of catgut, as the tissues are liable to retract—and if the ligature slips it is difficult to catch the artery, as I have reason to know. The anterior and posterior gastric branches are caught and tied in such a manner that the fat and glands, and distal part of the vessel can be dissected free from the upper part of the lesser curvature and a space an inch and a half in extent next to the cardiac orifice is exposed. This dissection should be very carefully made, because, as pointed out by Hartman and Mikulicz, it is essential that the whole of the lesser curvature to a point close to the cardiac orifice shall be removed. To a considerable extent the lymphatics lie in the wall of the stomach, and as demonstrated by Cunio, a large majority of pyloric cancers spread upward along the lesser curvature, and the failure to remove involved stomach is most apt to occur in this situation.

Step 3.—Careful examination is now made on the greater curvature for the glands which begin at a point about opposite the cardia. These glands are usually visible even when not diseased. The left gastro-epiploic vessels are caught and double-tied to the left of these glands, and the anterior and posterior gastric vessels caught and tied as they come from the stomach, and the greater curvature cleared for a space of at least an inch and a half. The transverse colon is drawn well into view so that the middle colic artery can be examined at frequent intervals to avoid injury, and the gastro-epiploic vessels tied with the gastrocolic omentum in sections from left to right sufficiently close to the transverse colon to leave the glands lying on the vessels of the greater curvature by a good margin. As this dissection proceeds it will sometimes be found that the avascular area which lies in the circle of the middle colic vessel and the posterior layer of the mesocolic peritoneum is attached to the growth. If this is the case the attached peritoneum can be cut out and removed with the growth. The opening thus made in the transverse mesocolon can be used later through which to make the gastrojejunostomy. As the dissection proceeds to the right the middle colic artery is carefully exposed and traced to its origin in the superior mesenteric artery just at the lower edge of the pancreas, otherwise it may be accidentally injured. Kronlein has shown that in three out of four cases obliteration of the middle colic vessel will lead to gangrene of a portion of the transverse colon and necessitate a coincident resection.

Step 4.—Removal of the inferior gastroduodenal glands which lie below and to the right of the pylorus about the head of the pancreas and in the curve of the duodenum, is the next step in the operation. The gastrocolic omentum is tied in sections rather close to the transverse colon, the fat and glands are lifted up from over the head of the pancreas, and the blood-vessels anastomosing with the branches of the superior pancreatoduodenal artery, are caught and tied. Separation is continued upward, clearing the inferior border of the duodenum for at least two inches until the gastroduodenal artery is reached in the groove between the pancreas head and the duodenum behind the pylorus. Division of these vessels allows raising in one piece all this important group of glands.

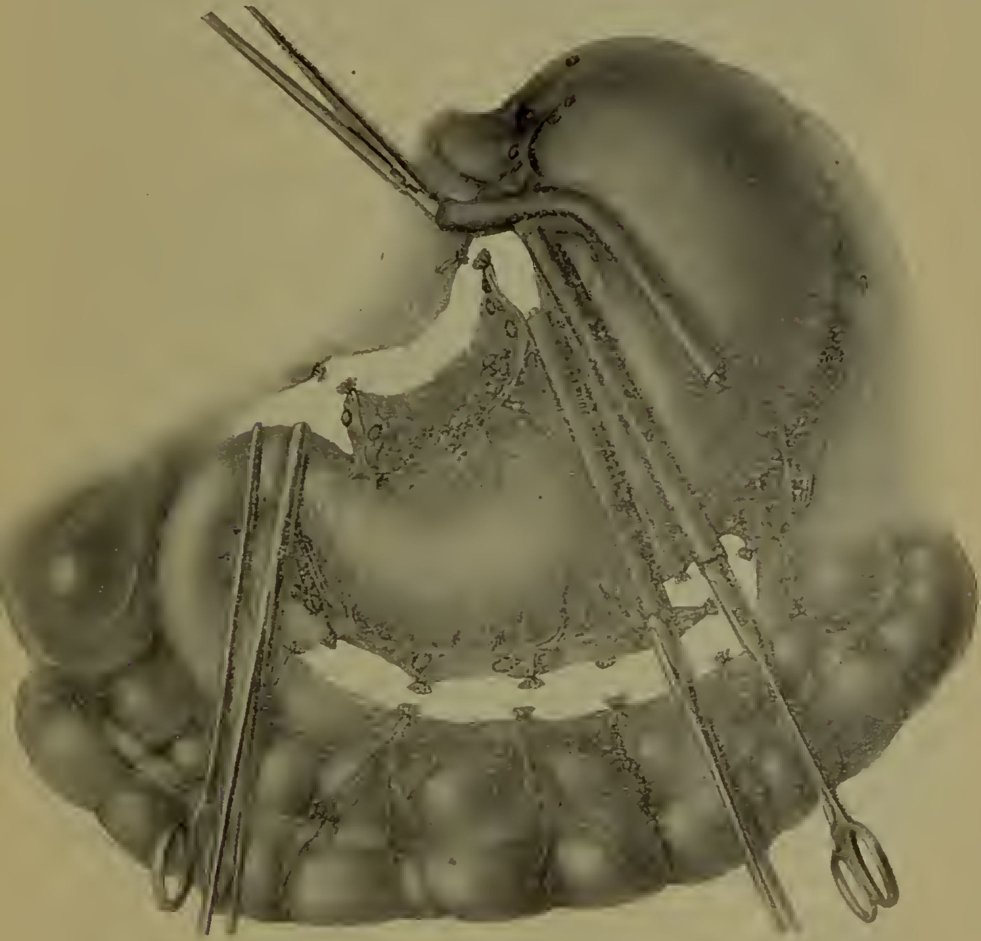

Fig. 3.—Clamps placed on the stomach and duodenum, isolating the pyloric end and lesser curvature.

Step 5.—The posterior surface of the upper duodenum is separated from the pancreas, and if the pancreas is adherent to the gastric growth, a piece is shaved off, allowing it to remain attached to the growth by adhesions. In other cases it becomes necessary to remove more or less of the pancreatic structure. If the involvement is extensive it is better to leave this part of the operation until the stomach is either cut across and separated from the duodenum, or the line of stomach section on the cardiac side is finished and the stomach turned over in order that this portion of the dissection may be completed under inspection. If such injuries to the pancreas are properly cared for, we have not found that they give rise to serious consequences. Haberkant found that a mortality of 76 per cent., and Mikulicz that a mortality of 74 per cent. followed the removal of such pancreatic involvement. It is the rule that these operations are more serious because more extensive but we have not found any special mortality due to operable pancreatic complication. The best manner of treating such an injury to the pancreas is to cover it as far as practicable with the sheath and posterior peritoneum, and after completely closing the end of the duodenum, if possible, the stump of the duodenum should be buried in the injured surface of the pancreas.

Step 6.—As a rule the duodenum beyond the pylorus is not involved to any considerable extent, but to make sure it is best to remove about an inch of it. A firm compression forceps is placed next to the pylorus and a half inch below this a pair of light holding clamps on the duodenum above and below to prevent this holding clamp from slipping off. The duodenum is divided between and both raw surfaces cauterized with the actual cautery. The pyloric end of the stomach is turned completely over on the left side of the patient. The stump of the duodenum is sutured with a continuous catgut suture passed through the duodenum and around the forceps as in the Pilcher operation for the removal of internal hemorrhoids. The holding clamp is slipped off, the catgut sutures drawn tight and tied. Three-fourths of an inch below this a purse-string suture of medium-sized linen is placed about the duodenum, the ends of the catgut strands are cut short and the duodenal stump invaginated in a manner similar to the stump of an appendix in appendectomy. A second linen purse-string suture is now placed about the duodenum; behind it catches the pancreatic sheath so that the stump may be buried against the head of the pancreas, as recommended by Willy Meyer. Finally the stump of the adjacent tied gastrocolic and gastrohepatic omenta are so adjusted by fine linen sutures as to make further protection. In our experience this technic has been adequate and we have had no cases of duodenal leakage. The field of operation is now searched for any bleeding points and protected with gauze.

Step 7.—The stomach is drawn to the right and holding clamps placed from the space cleared on the greater curvature in Step 3 to the space cleared on the lesser curvature in Step 2. When the stomach is cut across, these clamps sometimes slip near the cardia and the stomach retracts. To prevent this a pair of bayonet holding clamps are placed on the proximal side from above down, grasping the upper part of the stomach half-way across. A clamp is now placed distally to prevent leakage from the end to be amputated and the stomach divided between. The divided proximal gastric surface is cauterized with the actual cautery and the stomach turned in by a continuous chromic catgut suture beginning on the greater curvature. This suture is applied quite tight and is the one we have described on several occasions. It starts on the mucous surface, passes through all the coats to the peritoneum and back on the opposite side through all the coats to the mucous membrane, is then tied and the end cut short. The suture now passes through all the coats from the mucous to the peritoneal coat and begins on the opposite side by passing through all the coats from the peritoneum to the mucous and back on the same side from the mucous to the peritoneum. This is repeated on alternate sides until one-half to two-thirds of the stomach is closed. The cut margins now approach the transverse holding clamp so closely that inversion cannot be accomplished; this clamp is removed and the bayonet clamp, which grasps the upper part of the stomach to the left of the cardia, is depended on during the completion of the suture. A half dozen mattress tension sutures of medium sized linen are now placed, turning in the catgut row, and over this a continuous Cushing suture of fine linen makes all secure (Fig. 3).

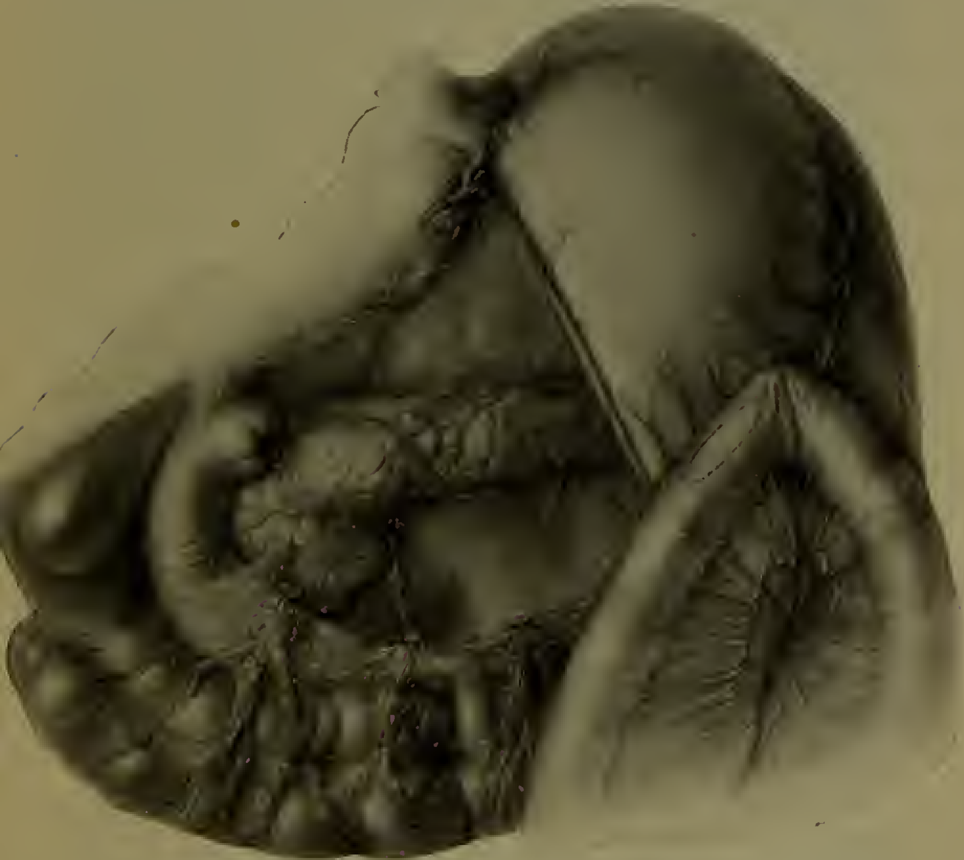

Fig. 4.—Restoration of gastro-intestinal continuity by an anterior gastro-enterostomy, which may be used in place of the posterior operation when the remaining stomach pouch is very small.

Step 8.—Restoration of gastro-intestinal continuity is best made by a posterior suture gastrojejunostomy with the jejunum passing to the left and as short as will permit the intestine to reach the stomach pouch without tension. In some cases the remaining pouch of the stomach is so small that anterior gastrojejunostomy on an 18-inch loop, the jejunum running to the right, can be done more easily and quickly, and has given equally good results (Fig. 4).

In doing the anterior gastrojejunostomy we have usually followed the method of Hartmann, i. e. the two-row suture method but in addition, as Hartmann recommended stitching the intestine to the stomach pouch an inch above the proximal side with a mattress suture. A second mattress suture is placed three fourths of an inch on the distal side attaching the jejunum to the tip of the stomach pouch. This prevents the jejunum from kinking on the gastrojejunal opening. Some operators make the gastrojejunostomy as the first step of the resection. We have done so on a few occasions. It is the rule, generally, that cancerous disease should be removed regardless of consequences and the repair made to fit the individual case. The gastrojejunostomy, if made primarily, may not always be at just the right point after the eradication of the disease. In selected cases the Kocher method of joining the duodenum to the stomach, can be used, inserting the cut end of the duodenum into the posterior wall of the closed pouch of the stomach. We have used the Kocher method but generally speaking, it is not as satisfactory as the Billroth No. 2 method, i. e. closing both the end of the duodenum and stomach and making an independent gastrojejunostomy. The Billroth No. 1 method, direct union between the cut end of the duodenum and gastric pouch, cannot often be used in malignant disease, although for benign disease, especially hour-glass ulcer, transverse resection in continuity and direct suture, give excellent results.

Some eminent surgeons believe that in serious cases we should do the gastrojejunostomy at one time, and after the patient has had an opportunity to pick up as the result of better feeding, to resect the stomach. We have followed this plan on two occasions, making the resection about two weeks after the gastrojejunostomy. In advanced disease gastrojejunostomy seems to be nearly as dangerous an operation as complete resection and because of the sloughing masses in the stomach, gastrojejunostomy does not furnish the rapid relief which is desired. Again, when the patient has recovered from his first operation he is inclined to procrastinate, or to refuse a second operation.

In regard to the question of shock in these debilitated individuals: The patient is given a moderate dose of morphin preliminary to anesthesia, which should be maintained to the very lightest degree during the visceral stage of the operation, as no pain is experienced at that time. As a rule the operation can be completed in from forty-five minutes to an hour and ten minutes, unless some complication arises. After operation the patient is kept warm and is put in the semi-sitting posture. If much debilitated he is given ten to fifteen minims of camphorated oil hypodermatically every four hours for several days. From four to six quarts of saline solution are given the first twenty-four hours by the Murphy method of rectal infusion. Two nutrient enemas are given in twenty-four hours for the first three or four days, by which time the patient will be able to take a sufficient amount of liquid nourishment by mouth. A moderate amount of hot water is allowed in the stomach from the start if borne well; after the first twenty-four hours, tea, broths, etc. may be given. Occasionally some blood and gastric secretion will accumulate in the stomach pouch in the first two days. This should be gently removed with a tube and the stomach irrigated with hot water.

OPERATIVE MORTALITY OF PYLORECTOMY AND PARTIAL GASTRECTOMY

In the 266 resections up to Jan. 27, 1910, there were thirty-four deaths or 12.4 per cent. During the year 1909 there were forty-six resections with four deaths, 8.6 per cent. mortality. This includes every case dying in the hospital without regard to the length of time following operation, and it includes all the early cases in which the mortality was high. In a way this is hardly fair to the statistics as many of the patients were in wretched physical condition at the time of operation, and some of these lingered along for weeks, dying eventually from exhaustion. The post-mortem showed the operative field to be in good condition. Yet this method of estimating the operative mortality seems to be the only way in which unprejudiced statistics can be compiled. If one begins to eliminate certain cases it is difficult to tell just where the line may be drawn fairly. While the operation is one of considerable magnitude if the patient is in good condition, the mortality is certainly under 5 per cent. and to a great extent the deaths are due to the patient's condition rather than to the operation itself. This brings up the question whether resection in advanced cases is worth the risk. I think it is. It should be borne in mind that these patients are usually admitted to the hospital with obstruction of such degree that the possibility of life is reduced to a few days or weeks. Gastrojejunostomy, with nearly the same mortality as resection in cancer, does not give great relief in these advanced cases owing to the discharges from the sloughing mass which pass downward into the intestinal tract and cause serious changes in metabolism, as contrasted with the patient's condition after resection of the cancerous stomach.

TABLE 3.—OPERATIONS FOR CANCER OF THE STOMACH FROM APRIL 21, 1897, to JAN. 27, 1910

ST. MARY'S HOSPITAL RECORDS

Total number	627
Explorations—Hopeless condition	206
Gastrojejunostomies	169
Gastrostomies	26
Excision of ulcer (with cancerous change)	2
Resection for cancer	224
	627

I am greatly indebted to Dr. J. F. Robinson for his painstaking care in ascertaining the present condition of patients, and for his aid in compiling the statistics.

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